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Available Information for Preparation of the Western Atlantic Bluefin Tuna (*Thunnus thynnus*) COSEWIC Status Report

Information disponible pour la préparation du rapport de situation du COSEPAC sur le thon rouge (*Thunnus thynnus*) de l'Atlantique occidental

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TABLE OF CONTENTS

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ABSTRACT

Atlantic bluefin tuna (*Thunnus thynnus*) has been identified as a candidate species by COSEWIC (Committee of the Status of Endangered Wildlife in Canada). To facilitate the preparation of the COSEWIC Status Report, recent information sources are identified, including both published and unpublished sources. The information is organized by subject area, including life history characteristics, population structure (referred to as "designatable units" by COSEWIC), and status including abundance and geographic extent.

RÉSUMÉ

Le thon rouge de l'Atlantique (*Thunnus thynnus*) a été désigné espèce candidate par le Comité sur la situation des espèces en péril au Canada (COSEPAC). Pour faciliter la préparation du rapport de situation du COSEPAC, les sources d'information récentes sont indiquées, y compris les sources publiées et non publiées. L'information est classée par domaine, notamment les caractéristiques du cycle biologique, la structure de la population (que le COSEPAC appelle « unités désignables ») et la situation, y compris l'abondance et l'aire géographique.

BACKGROUND

Atlantic bluefin tuna (*Thunnus thynnus*) has been identified as a candidate species by COSEWIC (Committee of the Status of Endangered Wildlife in Canada). Department of Fisheries and Oceans (DFO), as a generator and archivist of information on marine species and some freshwater species, represents a key contributor of information to COSEWIC. This information is usually gathered and reviewed through a pre-COSEWIC process put in place by DFO to ensure the best information available is provided in a timely fashion to COSEWIC authors. In the case of bluefin tuna, the DFO pre-COSEWIC process consisted essentially of gathering the various sources of information available that have already been peer-reviewed through other processes such as the scientific review of the Standing Committee on Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT).

This report summarises the available information for the use in the preparation of the COSEWIC Status Report. The document is organized following the usual topics addressed in a typical pre-COSEWIC meeting. Under each heading, key references or data sources are identified, along with annotations that the contractor may find helpful.

AVAILABLE DATA AND INFORMATION

1) Life History Characteristics

Growth Parameters

The ICCAT West Atlantic bluefin tuna stock assessment has used the growth model of Turner and Restrepo (1994), which was based on modal analyses for youngest ages and on information from mark and recapture studies for the older ages. More recent work (see Neilson and Campana 2008) has suggested that L_∞ is overestimated in that growth model, a conclusion supported by further investigation by Secor et al. (2008). Further work is ongoing in both the USA and Canada.

Current assessments for bluefin tuna are based on age-structured models, with catch-at-age inputs derived from "age slicing". Catch-at-size information is converted to catch age using the mean lengths-at-age predicted from the Turner and Restrepo (1994) model for ages 4-10, and modal separation for ages 1-3 (see p. 12 of the detailed report of the 2008 stock assessment http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf; ICCAT 2008).

The 50% age of first maturity is considered to be age 8 in the stock assessment based on the work of Baglin (1982), but there is controversy concerning this assumption. Diaz and Turner (2006) and others suggest later age at 50% maturity (age 11-12), but Goldstein et al. (2007) suggest an asynchronous reproductive schedule and smaller size at maturity.

Uncertainty in the growth model has substantial impacts for the stock assessment, and was considered in a preliminary fashion in Porch et al. (2008).

Relevant Literature – Growth Parameters

Baglin, R.E., Jr. 1982. Reproductive biology of western Atlantic bluefin tuna. Fish. Bull. Vol. 80(1): 121-134.

Diaz, G.A., and S.C. Turner. 2006. Size frequency distribution analysis, age composition, and maturity of western bluefin tuna in the Gulf of Mexico from the U.S. (1981–2005) and Japanese (1975–1981) longline fleets. ICCAT SCRS Doc. 2006/090.

Goldstein, J., S. Heppell, A. Cooper, S. Brault, and M. Lutcavage. 2007. Reproductive status and body condition of Atlantic bluefin tuna in the Gulf of Maine, 2000-2002. Mar. Bio. 151: 2063-2075.

ICCAT. 2008. Report of the 2008 Atlantic bluefin tuna stock assessment (Madrid, Spain – June 23 to July 4, 2008). http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf (last accessed 15 July 2009).

Neilson, J., and S. Campana. 2008. A validated description of age and growth of western Atlantic bluefin tuna (*Thunnus thynnus*). Can. J. Fish. Aquat. Sci. 65: 1523-1527.

Porch, C., V. Restrepo, and J. Neilson. 2008. Sensitivity of virtual population analyses of western Atlantic bluefin tuna to the use of an alternative growth curve for estimation of catch-at-age. ICCAT SCRS Doc. 2008/091.

Secor, D., R. Wingate, J. Neilson, J. Rooker, and S. Campana. 2008. Growth of bluefin tuna: Direct age estimates. ICCAT SCRS Doc. 2008/084.

Turner, S.C., and V.R. Restrepo. 1994. A review of the growth rate of western Atlantic bluefin tuna, *Thunnus thynnus*, estimated from marked and recaptured fish. Col. Vol. Sci. Pap. ICCAT 42: 170-172.

Total and Natural Mortality Rates and Recruitment Rates

The 2008 ICCAT stock assessment contains recent estimates of mortality rates and recruitment rates. Natural mortality (M) is assumed to be 0.14 yr-1, independent of age. In addition, Kurota et al. (2009) provide estimates of exploitation rates using a Bayesian approach that incorporates multiple types of tagging information.

An important aspect of the bluefin tuna assessment is the assumption concerning the relationship between recruitment and spawning stock biomass. As noted in the report of the 2008 stock assessment (ICCAT 2008), 2 alternative spawner-recruit hypotheses were explored: 2-line (hockey stick) and the Beverton and Holt formulation. The 2-line model assumes recruitment increase linearly with spawning stock biomass (SSB) from 0 with no spawners, to a maximum value (R_{MAX}) when SSB reaches a certain threshold. Here the SSB threshold (hinge) was set at the average SSB during 1989-1994 (a period of generally low estimated SSB), and R_{MAX} was calculated as the geometric mean recruitment during 1976-2004. The Beverton and Holt function was fit to the SSB and recruitment estimates corresponding to the period 1970-2004. The 2-line model results in lower estimates of the biomass associated with maximum sustained yield (B_{MSY}) than does the Beverton and Holt approach.

Relevant Literature – Mortality and Recruitment

Kurota, H., M.K. McAllister, G.L. Lawson, J.I. Nogueira, S.L.H. Teo, and B.A. Block. 2009. A sequential Bayesian methodology to estimate movement and exploitation rates using electronic and conventional tag data: Application to Atlantic bluefin tuna (*Thunnus thynnus*). Can. J. Fish. Aquat. Sci. 66: 321-342.

ICCAT. 2008. Report of the 2008 Atlantic bluefin tuna stock assessment (Madrid, Spain – June 23 to July 4, 2008). http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf (last accessed 15 July 2009).

Fecundity

Estimates of fecundity are more commonly available for eastern Atlantic bluefin tuna. However, for the west, Baglin (1976) reports fecundity of 16-33 million eggs in fish caught in the Bahamas (fork lengths ranged between 220-260 cm).

There is some uncertainty if annual spawning is obligatory for this species (see review by Fromentin and Powers 2005).

Relevant Literature -- Fecundity

Baglin, R. 1976. A preliminary study of the gonadal development and fecundity of the western Atlantic bluefin tuna. Col. Vol. Sci. Pap. ICCAT 5(2): 279–289.

Fromentin, J.-M., and J. Powers. 2005. Atlantic bluefin tuna: Population dynamics, ecology, fisheries and management. Fish Fish. 6: 281-306.

Generation Time

Based on validated ages of giant bluefin tuna from the southern Gulf of St. Lawrence, Neilson and Campana (2008) observed a maximum age of 32 years. The detailed report of the 2008 stock assessment (ICCAT 2008) contains catch-at-age tables for western bluefin tuna.

Relevant Literature – Generation Time

Neilson, J., and S. Campana. 2008. A validated description of age and growth of western Atlantic bluefin tuna (*Thunnus thynnus*). Can. J. Fish. Aquat. Sci. 65: 1523-1527.

ICCAT. 2008. Report of the 2008 Atlantic bluefin tuna stock assessment (Madrid, Spain – June 23 to July 4, 2008). http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf (last accessed 15 July 2009).

Early Life History Patterns

Spawning of western Atlantic bluefin tuna is generally thought to be localized to the Gulf of Mexico (see reviews by Rooker et al. 2007 (especially Figure 1) and Fromentin and Powers 2005), but there have been suggestions based on electronic tagging results that spawning could also take place in the central North Atlantic (Lutcavage et al. 1999), although this has not yet been confirmed. Rooker et al. (2007) provide a good account of the possibility of spawning outside of the Gulf of Mexico, and consider various hypotheses.

As noted in Fromentin and Powers (2005), bluefin tuna are oviparous and iteroparous. However, as noted by Rooker et al. (2007), there is some indirect evidence that bluefin tuna may not spawn each year. Bluefin tuna have asynchronous oocyte development and are multiple batch spawners. Eggs are buoyant and hatching happens without parental care after an incubation period of 2 days. Fish larvae (around 3-4 mm) are typically pelagic with a yolk sac and relatively undeveloped body form. The yolk sac is reabsorbed within few days, and then the larvae have to feed on their own.

Relevant Literature – Early Life History

Fromentin, J.-M., and J. Powers. 2005. Atlantic bluefin tuna: Population dynamics, ecology, fisheries and management. Fish Fish. 6: 281-306.

Lutcavage, M., R.W. Brill, G.B. Skomal, B.C. Chase, and P.W. Howey. 1999. Results of pop-up satellite tagging of spawning size class fish in the Gulf of Maine: Do North Atlantic bluefin tuna spawn in the mid-Atlantic? Can. J. Fish. Aquat. Sci. 56: 173-177.

Rooker, J.W., J.R. Alvarado Bremer, B.A. Block, H. Dewar, G. de Metrio, A. Corriero, R.T. Kraus, E.D. Prince, E. Rodriguez-Marin, and D.H. Secor. 2007. Life history and stock structure of Atlantic bluefin tuna (*Thunnus thynnus*). Rev. Fish. Sci. 15: 265–310.

Specialised Niche or Habitat Requirements

Scott and Scott (1988) provide a useful overview of the habitat requirements of bluefin tuna in Canadian waters. Among tuna species occurring in Canadian waters, the spatial distribution of bluefin tuna is more coastal (see, for example, the distribution of bluefin tuna shown in relation to bigeye tuna shown in Figure 10 of Neilson et al. (2004)). Spawning occurs outside of Canadian waters, with spawning areas described in Rooker et al. (2007). In comparison with other large pelagic species such as swordfish (*Xiphias gladius),* which have a prolonged spawning season and muttiple spawning areas (Neilson et al. 2006), bluefin tuna have circumscribed spawning requirements.

Bluefin tuna occur in Canadian waters for feeding purposes, and feed extensively upon herring, mackerel ,and squid (see S2.3 of Rooker et al (2007) for details). Therefore, maintaining healthy populations of these prey species in Canadian waters is an obvious consideration for habitat. Published work reviewed by Fromentin and Powers (2005) appears to support the view that juvenile and adult bluefin tuna also frequent and aggregate along ocean fronts (Humston et al. 2000; Lutcavage et al. 2000; Royer et al. 2004). This association is also likely to be related to foraging opportunities, as there are abundant vertebrate and invertebrate prey in such areas (e.g., Boustany et al. 2001; Brill et al. 2001).

Relevant Literature – Niche or Habitat Requirements

Boustany, A.M., D.J. Marcinek, J. Keen, H. Dewar, and B.A. Block. 2001. Movements and temperature preferences of Atlantic bluefin tuna (*Thunnus thynnus*) off North Carolina: A comparison of acoustic, archival, and pop-up satellite tags; pp. 89-108. In J.R. Sibert and J.L. Nielsen (Editors). Electronic tagging and tracking in marine fisheries, Kluwer Academic Publishers, Dordrecht.

Brill, R.W., and M.E. Lutcavage. 2001. Understanding environmental influences on movements and depth distributions of tunas and billfishes can significantly improve population assessments. Am. Fish. Soc. Symp. 25: 179-198.

Fromentin, J.-M., and J. Powers. 2005. Atlantic bluefin tuna: Population dynamics, ecology, fisheries and management. Fish Fish. 6: 281-306.

Humston, R., J.S. Ault, M. Lutcavage, and D.B. Olson. 2000. Schooling and migration of large pelagic fishes relative to environmental cues. Fish. Oceanogr. 9: 136-146.

Lutcavage, M.E., R.W. Brill, G.B. Skomal, B.C. Chase, J.L. Goldstein, and J. Tutein. 2000. Tracking adult North Atlantic bluefin tuna (*Thunnus thynnus*) in the northwestern Atlantic using ultrasonic telemetry. Mar. Bio. 137: 347-358.

Neilson, J.D., H.H. Stone, and E.H. 2004. Carruthers. 2004. Development of the Canadian fishery for bigeye tuna (*Thunnus obesus*) from 1994 to 2002. ICCAT SCRS Doc. 2004/052.

Neilson, J.D., S.D. Paul, and S.C. Smith. 2006. Stock structure of swordfish (*Xiphias gladius*) in the Atlantic: A review of the non-genetic evidence. ICCAT SCRS Doc. 2006/025.

Rooker, J.W., J.R. Alvarado Bremer, B.A. Block, H. Dewar, G. de Metrio, A. Corriero, R.T. Kraus, E.D. Prince, E. Rodriguez-Marin, and D.H. Secor. 2007. Life history and stock structure of Atlantic bluefin tuna (*Thunnus thynnus*). Rev. Fish. Sci. 15: 265–310.

Royer, F., J.-M. Fromentin, and P. Gaspar. 2004. The association between bluefin tuna schools and oceanic features in the Western Mediterranean Sea. Mar. Ecol. Progr. Ser. 269: 249-263.

Scott, W.B., and M.G. Scott. 1988. Atlantic fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219.

2) Review of Designatable Units

There have been considerable recent developments in our understanding of bluefin tuna stock structure. Based on a study of otolith microconstituents (Rooker et al. 2008), it was noted that North American mid-Atlantic fisheries receive a considerable subsidy of migrants from the eastern Atlantic. Canadian fisheries, in contrast, receive virtually no immigration from the eastern Atlantic and are supported by western (Gulf of Mexico) spawners. A submitted paper (Schloesser et al., available from the author of this research document) expanded the range of samples included in the otolith microchemistry analyses to include material collected in the 1970s and 1980s, as well as the contemporary period, and confirmed that over this extended period, the natal origin of fish in the Canadian southern Gulf of St. Lawrence fishery was the Gulf of Mexico in more than 99% of the samples. Mixing of eastern and western components remains an active field of research, however.

Rooker et al. (2008) also commented on the high degree of spawning site fidelity, comparable to that observed for Pacific salmon. From a stock recovery perspective, this is noteworthy, since it implies that there is not likely to be a "rescue effect" associated with immigration from the east Atlantic to the spawning grounds.

Electronic tagging work conducted by Block et al. (2008) indicate that from the results available at the time of publication, fish tagged in the Gulf of St. Lawrence either moved into the Gulf of Mexico during the time of spawning, or into the western North Atlantic. To date, none of the fish had a geoposition in the eastern Atlantic management unit. M. Lutcavage and collaborators have also applied electronic tags off southwest Nova Scotia, and more recently, near the Virgin Rocks in Northwest Atlantic Fisheries Organization (NAFO) Subarea 3. Preliminary results from

the tagging programs from Lutcavage and collaborators show considerable variability in migration routes followed by fish tagged in Canadian waters. Both research teams are preparing publications containing information relevant to the COSEWIC Status Report, and will be forwarded to the contractor as they become available.

The notion of "metapopulations" is gaining more support in the scientific community for bluefin tuna, and the review paper of Fromentin and Powers (2005) contains a good discussion of the possible models of stock structure. Metapopulation theory predicts that local depletions can occur (Smedbol et al. 2002), and this appears consistent with the loss of the Nordic and Brazilian fisheries. A recent symposium held in Santander, Spain, focussed on case studies involving loss of population components of bluefin tuna in the Atlantic (http://www.iccat.int/Documents/Meetings/Docs/BFT_SYMP_REPORT.pdf; ICCAT 2008).

Relevant Literature – Designatable Units (Stock Structure)

Block, B.A., G.L. Lawson, A.M. Boustany, M.J.W. Stokesbury, M. Castleton, A. Spares, J.D. Neilson, and S. Campana. 2008. Preliminary results from electronic tagging of bluefin tuna (*Thunnus thynnus*) in the Gulf of St. Lawrence, Canada. ICCAT SCRS Doc. 2008/092.

Fromentin, J.-M., and J. Powers. 2005. Atlantic bluefin tuna: Population dynamics, ecology, fisheries and management. Fish Fish. 6: 281-306

Rooker, J., D. Secor, G. de Metrio, R. Schloesser, B. Block, and J. Neilson. 2008. Natal Homing and Connectivity in Atlantic Bluefin Tuna Populations. Sci. 322: 742-744.

Schloesser, R.W., J.D. Neilson, D.H. Secor, and J.R. Rooker. (Accepted). Natal origin of Atlantic bluefin tuna (*Thunnus thynnus*) from the Gulf of St. Lawrence based on δ13C and δ18O in otoliths. Can. J. Fish. Aquat. Sci.

Smedbol, R.K., A. McPherson, M.M. Hansen, and E. Kenchington. 2002. Myths and moderation in marine metapopulations. Fish Fish. 3: 1-15.

ICCAT. 2008. Report of the world symposium for the study into the stock fluctuation of northern bluefin tunas (*Thunnus thynnus* and *Thunnus orientalis*), including the historic periods (Santander, Spain – April 22 to 24, 2008). http://www.iccat.int/documents/meetings/docs/bft_symp_report.pdf (last accessed 15 July 2009).

3) Review the COSEWIC Criteria for Western Atlantic Bluefin Tuna in Canada

COSEWIC Criterion – Declining Total Population

a. Summarise overall trends in population size (both number of mature individuals and total numbers in the population) over as long a period as possible, and in particular for the past three generations (taken as mean age of parents). Additionally, present data on a scale appropriate to the data to clarify the rate of decline.

The assessment generally relies upon catch per unit effort (CPUE) series provided by the USA, Canada, and Japan. A larval survey from the Gulf of Mexico is also used, and is the only fishery-independent abundance index available for the stock. The quality of data to derive population for western bluefin tuna is considered good by the SCRS. However, recreational

fisheries represent a possible exception to the overall high level of monitoring, but the extent of this issue has not yet been quantified.

There is a well-documented decline in abundance that has resulted in ICCAT establishing a 20-year rebuilding program starting in 1999, with the objective of recovering the stock to B_{MSY} with at least a 50% probability by the end of the Plan's time frame (through 2018, assuming the low recruitment scenario).

Recent estimates of population numbers at age are available to assist the contractor with this task, and can be found in the detailed report of the 2008 stock assessment (http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf; ICCAT 2008), see in particular Appendix 9, p. 164, for the matrix of population numbers at age that could be used to generate plots of the numbers in the population. The available data are from 1970 to 2007.

b. Identify threats to abundance - where declines have occurred over the past three generations, summarise the degree to which the causes of the declines are understood, and the evidence that the declines are a result of natural variability, habitat loss, fishing, or other human activity.

Possible reasons for the decline include very high exploitation rates on the larger eastern component (which, as noted earlier, mixes with the western stock during parts of the life history). Fromentin and Powers (2005) also commented that Atlantic bluefin tuna as a whole has been undergoing heavy overfishing for a decade. The most recent assessment supports the view that the stock has been overfished, and is in a depleted state.

c. Where declines have occurred over the past three generations, summarise the evidence that the declines have ceased, are reversible, and the likely time scales for reversibility.

The spawning stock biomass and recruits have remained relatively stable (at a historically low level) since the mid-1980s, and the population as a whole has not responded positively to management actions and the Rebuilding Plan. Notwithstanding this, the harvest levels adopted by the Commission in 2008 (the response of the Commission to the Science advice contained in the management plan adopted in 2008 can be found here: http://www.iccat.int/Documents/Recs/compendiopdf-e/2008-04-e.pdf; ICCAT 2008b) are consistent with the science advice, in that the planned fishery removals should allow rebuilding to take place with a higher (75%) level of probability than that used by the Commission in the past (see Executive Summary, including a decision table indicating probability of meeting rebuilding plan targets, ICCAT 2008a). However, there are considerable uncertainties in the projections of rebuilding, including the accuracy of the growth curve currently used in the assessments and the extent of mixing between the eastern and western components. While there has been some important recent progress towards addressing these questions of mixing, it is broadly recognized that more work needs to be done to quantify the extent of mixing (see, for example, the Report of the Independent Performance Review of ICCAT) and integrate a more accurate growth curve in future assessments and rebuilding forecasts.

A recent workshop co-sponsored by Canada and ICCAT indicated some systematic problems with the assessment of bluefin tuna, in that projections of future population levels have tended to be overly optimistic (Gavaris et al. 2008). However, some of the technical issues (such as modeling the terminal-year fishing mortality rates) with the stock assessment were investigated in advance of the 2008 stock assessment, and methods to address them were identified and incorporated (Walter and Porch 2008).

Relevant Literature – Population Abundance

ICCAT. 2008a. Executive summary – Bluefin Tuna (BFT). http://www.iccat.int/Documents/SCRS/ExecSum/BFT_EN.pdf (last accessed 15 July 2009).

ICCAT. 2008b. Supplemental recommendation by ICCAT concerning the western Atlantic bluefin tuna rebuilding program. http://www.iccat.int/Documents/Recs/compendiopdf-e/2008-04-e.pdf (last accessed 15 July 2009).

Gavaris S. (Chairman), F. Hazin, J.N. Neilson, P. Pallares, C. Porch, V.R. Restrepo, G. Scott, P. Shelton, and Y. Wang. 2008. Proceedings of the Joint Canada-ICCAT 2008 Workshop on the precautionary approach for western bluefin tuna (Halifax, Nova Scotia, 17-20 March, 2008). ICCAT SCRS Doc. 2008/013.

Walter, J., and C. Porch. 2008. Three different strategies for modeling the terminal-year fishing mortality rates in virtual population analyses of western bluefin tuna: Retrospective patterns and consequences for projections. ICCAT SCRS Doc. 2008/089.

COSEWIC Criterion – Small Distribution and Decline or Fluctuation

For the species in Canada as a whole, and for designatable units identified, using information in the most recent assessments:

a. Summarise the current extent of occurrence (in km^2) in Canadian waters.
b. Summarise the current area of occupancy (in km^2) in Canadian waters.
c. Summarise changes in extent of occurrence and area of occupancy over as long a time as possible, and in particular, over the past three generations.
d. Summarise any evidence that there have been changes in the degree of fragmentation of the overall population, or a reduction in the number of meta-population units.
e. Summarise the proportion of the population that resides in Canadian waters, migration patterns (if any), and known breeding areas.

The recent stock-wide distribution of western bluefin tuna is show in Figure 1. In reference to points a. to c. above, the Large Pelagics Program at the St. Andrews Biological Station is able to provide maps of the spatial occurrence of bluefin tuna in Canadian Atlantic waters, as well as georeferenced data for calculations of extent of area occupied. An example of the type of maps that can be produced appears in Figure 2.

With regard to point d., there have been losses of Canadian bluefin tuna aggregations that supported fisheries. One documented case is the feeding aggregation that supported the inshore Wedgport, Nova Scotia, sport fishery from 1935 to 1966 (Clay and Hurlbut, unpublished report, see also the Wedgeport Tuna Museum website http://tuna.mindseed.ca/). However, there have also been instances of new aggregations that now support fisheries. An example would be the "Hell Hole" off Georges Bank. Recent Canadian national reports to ICCAT provide details of such fisheries, along with finer-scale catch statistics for those components.

Bluefin tuna are seasonal residents in the Canadian Atlantic zone, and the fisheries are active between July and November. The proportion of the Western Atlantic population that resides in Canadian waters is not known. There are two teams of researchers that have been conducting electronic tagging studies in Canadian waters. Such studies allow description of approximate migration paths within Canadian waters. However, the publications are not yet available and unlikely to become so in time for preparation of the COSEWIC Status Report.

Relevant Literature – Loss of Population Components

Clay, D., and T. Hurlbut. Unpublished. Canada's Atlantic bluefin tuna (*Thunnus thynnus* (L.)) fisheries to 1995. Unpublished draft report, available from the author of this research document (John D. Neilson).

COSEWIC Criterion – Small Total Population Size and Decline and Very Small and Restricted Distribution

For the species in Canada as a whole, and for designatable units identified, using information in the most recent assessments:

a. Tabulate the best scientific estimates of the number of mature individuals; and
b. If there are likely to be fewer than 10,000 mature individuals, summarise trends in numbers of mature individuals over the past 10 years or 3 generations, and, to the extent possible, causes for the trends.

Recent data are available to inform this task, and can be found in the detailed report of the 2008 stock assessment (http://www.iccat.int/Documents/SCRS/DetRep/DET_BFT_EN.pdf; ICCAT 2008), see in particular Appendix 9, P. 164 for the matrix of population numbers at age that could be used to generate plots of the numbers in the population. The available data are from 1970 to 2007.

Relevant Literature – Small Total Population Size

ICCAT. 2008. Report of the 2008 Atlantic bluefin tuna stock assessment (Madrid, Spain – June 23 to July 4, 2008). http://www.iccat.int/Documents/SCRS/DetRep/ DET_BFT_EN.pdf (last accessed 15 July 2009).

4) Describe the Characteristics or Elements of the Species Habitat to the Extent possible, and Threats to that Habitat

Habitat is defined as "in respect of aquatic species, spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced".

a. Describe the functional properties that a species' aquatic habitat must have to allow successful completion of all life history stages.

Spawning and habitat for larval and juvenile stages occur outside of Canadian waters. Given that bluefin tuna are in Canadian waters for foraging, the key consideration here would be the availability of healthy populations of prey species to support the populations of bluefin tuna. In this regard, DFO science advisory reports (2005 to present) and/or stock status reports (1993-2004) for Atlantic Canadian stocks of herring, mackerel, and squid would be of interest to summarise. These reports are available at the CSAS website (http://www.meds-sdmm.dfo-mpo.gc.ca/csas/applications/Publications/publicationIndex_e.asp).

b. Provide information on the spatial extent of the areas that are likely to have functional properties.

Canadian Atlantic bluefin fisheries occur on foraging aggregations of bluefin tuna, thus the spatial extent of the fisheries provides some indication of the habitat of bluefin tuna. Neilson et

al. (2008) provide recent fishery distribution information, and other data representations can be prepared by Large Pelagics Program.

c. Identify the activities most likely to threaten the functional properties, and provide information on the extent and consequences of those activities.

There have been reports of decreased condition of bluefin tuna in USA fisheries in the Gulf of Maine area (Golet et al. 2007) and in the Canadian southern Gulf of St. Lawrence fishery (Neilson et al. 2008). However, the biological significance of these trends is unclear, and difficult to relate to problems with food supply.

Relevant Literature – Habitat

Golet, W.J., A. Cooper, R. Campbell, and M. Lutcavage. 2007. Decline in condition factor of Atlantic bluefin tuna (*Thunnus thynnus*) in the Gulf of Maine. Fish. Bull. 105: 390–395.

Neilson, J.D., S. Smith, M. Ortiz, and B. Lester. 2008. Indices of stock status obtained from the Canadian bluefin tuna fishery. ICCAT SCRS Doc. 2008/083.

5) Describe to the Extent Possible Whether the Species has a Residence as Defined by *Species at Risk Act* (SARA)

SARA S.2(1) defines Residence as "a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating."

Under this definition, bluefin tuna do not have "residences" in Canadian waters.

6) Threats

A threat is any activity or process (both natural and anthropogenic) that has caused, is causing, or may cause harm, death, or behavioural changes to a species at risk or the destruction, degradation, and/or impairment of its habitat to the extent that population-level effects occur. Guidance is provided in: *Environment Canada, 2007. Draft Guidelines on Identifying and Mitigating Threats to Species at Risk. Species at Risk Act Implementation Guidance.*

Adult bluefin tuna have few natural predators, but killer whales (*Orcinus orca*), pilot whales (*Globicephala melaena*), and mako sharks (*Isurus oxyrinchus)* have been observed to occasionally prey upon them (Scott and Scott 1988). A secondary threat of unknown origin has caused a declining trend in body condition, as described in the habitat section.

The main known anthropogenic threat is associated with overfishing, as described earlier. Song et al. (2006) described the morphology of the inner ear of bluefin tuna, and commented on the susceptibility to anthropogenic noise, such as from seismic testing. Based on the likelihood that bluefin tuna do not have particularly good hearing, those authors suggested that for any sound to be detected by tuna, it would have to be very loud. Therefore, the possibility of damage appeared to be discounted. Finally, although spawning areas occur outside of Canadian waters, it is possible that climate change could have profound impacts on this species, given the relatively narrow requirements for spawning described earlier.

Conventional tagging results (Porter et al. 1994) and preliminary electronic tagging results (M. Lutcavage, pers. comm.) indicate that bluefin tuna show considerable fidelity to foraging areas, often returning precisely to the same area that they were tagged and released 1 year

earlier. If this observation of fine-scale population structure is confirmed, there may be a requirement for management measures at a complementary spatial scale.

Relevant Literature – Threats

Porter, J.M., M.J.W. Stokesbury, C.A. Dickson, and W.E. Hogans. 1994. A mark-recapture experiment on bluefin tuna (*Thunnus thynnus* L.) from the Browns-Georges Banks region of the Canadian Atlantic: 1993 update. Col. Vol. Sci. Pap. ICCAT 42(1): 150-153.

Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219.

Song, J., A. Mathieu, R.F. Soper, and A.N. Popper. 2006. Structure of the inner ear of bluefin tuna *Thunnus thynnus*. J. Fish Bio. 68: 1767-1781.

7) Other Trends in Indicators Relevant to Evaluating the Risk of Extinction of the Species

The USA recreational fishery for bluefin tuna collects information on the length of fish caught. Recent information suggest that there may be a relatively strong year-class passing through this fishery (2003 year-class), which may facilitate the rebuilding process for the stock. However, the stock origin of this group is not known.

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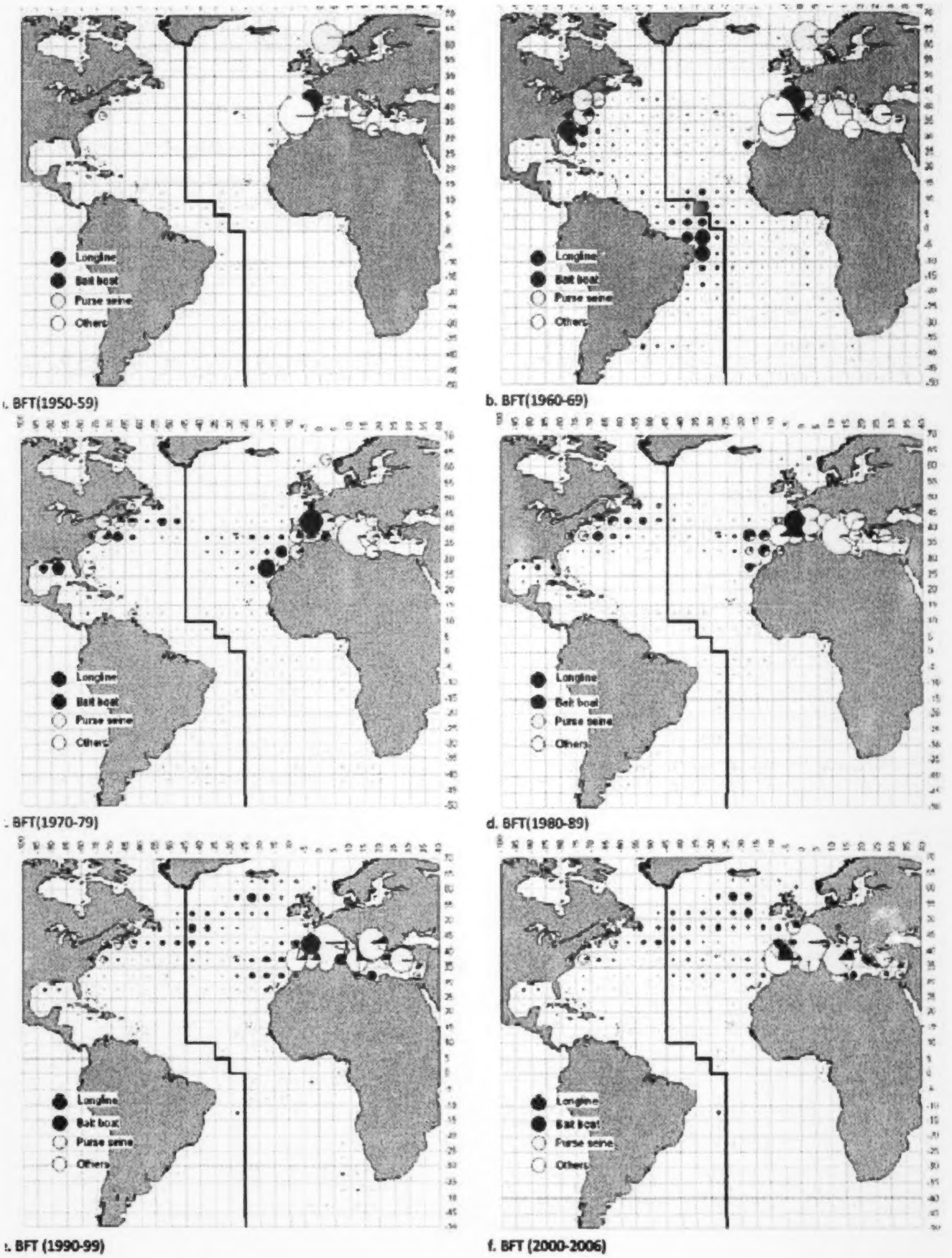

Figure 1. Spatial distribution of catches of Atlantic bluefin tuna in the ICCAT Convention area, shown by gear and period. Source: http://www.iccat.int/Documents/SCRS/ExecSum/BFT_EN.pdf (last accessed 15 July 2009).

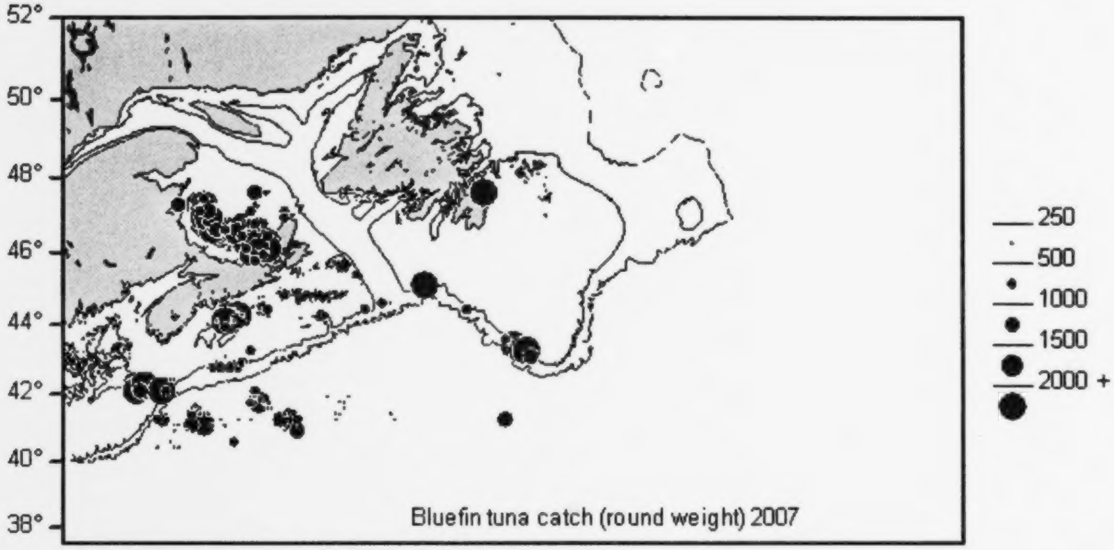

Figure 2. Spatial distribution of the catch of bluefin tuna in the Canadian Atlantic zone in 2007, showing catch by all gear types, with the exception of the trap fishery in St. Margaret's Bay. DFO has georeferenced catch data for 1997-2008 in a readily accessible form. Additional data are available from 1988 to 1996, but would require more time to assemble should the COSEWIC contractor require them. Finally, logbook information is available from 1978 to 1987, but requires more work (possibly including coding) to access.